Coping with Bounded Rationality: A Review of Contrasting Conceptions of Rationality in Economics and the Methodological Implications therein.

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Introduction

Bounded rationality is a contemporary conceptual explanation of human decision-making that respects the limited nature of human cognitive capacity. Pertaining to decisions about how to satisfy and indeed, formulate human needs and desires, bounded rationality theory is of great relevance to economics, which examines the phenomena of human consumption and work, and the choices made therein. In particular, theories of bounded rationality lie in contradiction to the discipline's most prevalent school of thought, *neoclassical* economics, which holds simplifying assumptions about agent's motivations and methods for electing courses of action.

This review seeks to clarify and evaluate some ideas about rationality across the orthodox and heterodox approaches in economics, beginning with an analysis of the theoretical development behind the neoclassical treatment of the term, then introducing some alternative, *institutional* conceptions of economic agents' rationality, focusing on bounded rationality and derived theories in a similar vein. A short summary of the empirical methods available to the study of agents' rationality then precedes some methodological debate, before a final section in which I draw some conclusions about the current state of the debate, including some proposals for the future direction of research, informed by the literature referenced.

I take what I feel is a humble position, with some considerable respect for each side of what I perceive to be a debate deficient of simple answers, and with profound implications for the understanding of economics.

Theoretical Development

Rationality in the unmodified neoclassical model of economics has two distinct and important features; it is both *perfectly instrumental* and *perfectly self-interested.* By perfectly instrumental, it is meant *categorically efficient at optimising*, and by *self-interested*, we can read *greedy*. Of immediate interest is that neither of these features are typically meant in colloquial parlance. A concise dictionary certainly does not step into such controversial territory by placing egotist requirements on the definition or rationality. Nevertheless, this conception of rationality, with its particular peculiarities, is an integral cornerstone of what became the dominant school of thought in economics, that is the neoclassical research programme. Though later I will review some very modern work that questions the continuity of the neoclassical economics' dominance, here I shall aim to further consider some of the interesting methodological implications, including limitations, of such a conception of rationality.

In Rothschild's interpretive *The Meaning of Rationality: A Note on Professor Lange's Article* (Rothschild, 1946) Professor Lange is quoted as suggesting households are more complicated than firms in their rationality. Only households in modern capitalist societies, it is argued, have developed a neoclassical-style utility-maximising habit, one that is derived from the world of profit-maximising business. Rothschild criticises Lange not for this, but for apparent ambiguity, owing to an insufficient explanation of exactly what 'rationality' should be taken to mean here, given that it has so many available interpretations. Going on in an attempt to clarify on behalf of Lange, Rothschild suggests that rationality is being referred to in the sense widely established within economics, but then asserts that such a utility or profit-maximising interpretation is insufficient.

As a general concept, rationality pertains to the particularly neoclassical-compatible field of rational choice theory, itself a branch of decision theory, in accordance with which each individual agent chooses the best action according to their own estimation, in the face of environmental constraints. What constitutes the best action, is that which best satisfies each agent's preferences which are deemed *exogenous* in the neoclassical model. This introduces utility theory, originally introduced in the unrefined utilitarianism of Bentham (cited in Himmelweit et al., 1998, *Markets*, pp.62-4), where utility itself can be thought of as *preference satisfaction.* Utility functions, effectively short-hand for unobserved indifference maps, are also necessarily postulated by the orthodox economic theory, thus creating a model agent that is infinitely competent in making decisions to the benefit of their own subjectively selected, non-lexicographic ends. In achieving the maximum possible benefit to their own utility, neoclassical economics refers to their behaviour as *maximising.*

Maximising is to be a dominant theme throughout this review, and its proximity with the neoclassical conception of rationality is expressed in the following definition; 'A unit of economic decision is said to act rationally when its objective is the maximisation of a magnitude.' (Lange, O., cited in Rothschild, 1946). And so while agents or households seek to maximise utility, firms are expected in the neoclassical theory to maximise profit. All agents' profit or utility-maximising choices are affected by market prices that convey a quantitative measure of the dis-utility, or opportunity cost, of procuring consumables. Thus prices are an important part of the aforementioned environmental constraints that rational agents must hold in mind. Such an able, maximising model agent has been named *homo economicus*, by critics of John Stuart Mill, who's writing on political economy represented the beginnings of much of the 'rationality' debate when he phrased his proposition of human nature, beautifully as was typical of him; man is described 'as a being who desires to possess wealth, and who is capable of judging the comparative efficacy of means for obtaining that end' (Mill, 1874, p.105).

Rothschild's article (1946) seems to ignore the elegant concept of revealed preferences, by feeling it necessary to defend the rationality of individuals not participating in behaviour associated with Lange's 'capitalist spirit'. Examples of tribal people prepared to suffer hardship for some respectable gain, unsatisfied with easier goals, seem to lack clarification as to why decreasing marginal utility to easier goals is not a readily available explanation. An unconvincing attack is also launched on the supposition of self-interested maximisation with an example from Christianity. 'The true Christian will cease to desire a thing if his possession of it will hurt the feelings of those who have to do without it.' (Rothschild, 1946, p.51). While not my strong point, my understanding of Christianity is that only a respectable, community-oriented life can precede admittance to a preferable after-life, itself constituting a greater part of existence than mortal life, and as opposed to something punishing. Surely this issue defeats any criticism of omnipresent selfishness, instead buttressing such a view.

It would not seem logical to write so much on economists' treatment of human agents' rationality without some passing consideration for such agents' immense capacity for *irrationality,* the study of which neoclassical economics conveniently eschews. Examples of irrational behaviour debated in economics are too numerous to do justice to here, but to aid their compartmentalisation, a description of three classes of irrationality is provided by Rothschild (1946, p.51).

Real irrationality is 'Purely emotional, impulsive actions, which, on consideration, would be rejected even though no new information was forthcoming'. The author of this definition suggests there may be some, as of yet unexplained rationality in these action, but for economists in particular, it is a moot point.

Irrationality born from ignorance includes problems from imperfect information or understanding, a perhaps powerful critique of the neoclassical reliance on impeccably rational agents, depending on the extent to which such irrationality is prevalent (the bulk of this analysis is to follow in later sections of this review).

Irrationality as deviation from the 'capitalist spirit'. Despite apparent objection to this being properly deemed irrationality, Rothschild provides a definition that legitimises exactly that, but using an illuminating example of Veblen's indications that some twisted motivations can perhaps be deemed 'rational' where they serve to increase satisfaction. Along 'capitalist spirit' lines, Smith (1991, cited in Hodgson, 2007, p.10) writes 'institutions serve as social tools that reinforce, even induce individual rationality'. And so it has been criticised that economics students become more selfish, in practise, through study of economics itself. For example, they are less willing to co-operate with the other player in a prisoner's dilemma structured game, making the *homo economicus* model a possibly self-fulfilling prophecy (Frank et al., 1993).

In fact a plethora of criticisms are possible for most of the theoretical components so far mentioned, but following them all would necessitate an extremely long analysis. The purpose of this paper is most interested in the neoclassical postulate of instrumental rationality with *perfect knowledge* in models, including possible alternative conceptions that may also be accommodated in alternative general theories of economics.

No sooner than the phrase 'perfect knowledge' is used, I feel one immediate question is begged; how important is perfect knowledge in agents' decision-making, to neoclassical economics? Fortunately for neoclassical economics, I feel, such a feature of rational decision-making is a non-core assumption. Only hardcore neoclassical traditionalists believe in the power of modelling agents with perfect knowledge, let alone perfect information. In fact, 'There are now modified versions of neoclassical theory that allow for agents being uncertain' (Callaghan et al., 2007), namely *new institutional economics,* which is modified from the neoclassical programme, abandoning reliance on perfect information and instrumental rationality.

Institutions are properly described by economists as 'the rules of the game' (Landa et al., 2001). While Hodgson (2007) rightly objects that even the neoclassical approach is not entirely free of institutions, the market and price systems themselves being entrenched institutions, *institutional economics* is a collection of theories that focus on the roles of institutions in shaping economic behaviour, all of which relax one or more features of the core neoclassical preoccupation with *equilibrium*, the *price mechanism*, *methodological individualism* and highly efficient, self-interested *rationality* (Callaghan et al., 2007). In what seems to reflect a quite humorous problem with naming conventions, Hodgson titles a section of a paper 'The Changing New Institutional Economics' (Hodgson, 2007, p.12-14). Here, revealing the authors apparent affinity for the old institutional school, a very valid criticism is made in that long before we even learn the concept of a market, we undergo a socialisation process that makes for great difficulty in accepting explanatory models with purportedly institution-free starting points. Further more, with reference to Trygve Haavelmo's 1989 lecture (cited in Hodgson, 2007, pp.12-3) on receipt of the Nobel Prize, it is argued that it is simply unnecessary, let alone uninteresting to have a fetish for atomistic, institution-free starting points.

The *behavioural, biological, cognitive, evolutionary, experimental* and *game theory* streams of the wider heterodox economics have supplied some alternative suggestions for treating and understanding human rationality. Hodgson (2007) attributes the origins of institutional, and evolutionary ideas in particular, to Adam Smith, Thorstein Veblen, Joseph Schumpeter, Friedrich Haye, Richard Nelson and Sidney Winter among many. To borrow from Kenneth Arrow (1995, cited in Hodgson, 2007, p.9), 'For a century, some economists have maintained that the biological is a more appropriate paradigm for economics than equilibrium models analogous to mechanics.' Arrow contrasts the mechanics-inspired neoclassical approach with a growing heterodox allegiance with biological science, evolution in particular. These new ideas have been spurred on quite recently, and to no small extent by much of the work of Herbert Simon.

Simon, who was active in the field of cognitive psychology among many disciplines, was not the first to refute the neoclassical conception of infinitely rational agents. Indeed a footnote in *Evolutionary and Institutional Economics as the New Mainstream* (Hodgson, 2007, p.11) places the origins of concepts of *uncertainty* in the early work of Knight and Keynes. But Simon was the first to coin the term attached to his increasingly fashionable concept of *bounded rationality*, which stresses the fact that instrumentally rational decisions are not feasible in practice due to the limited cognitive abilities of agents making them, in addition to the finite time and information resources with which to compute. It is a central theme in the behavioural approach to economics, relaxing the assumptions of the subjective utility theory and perfectly instrumental rationality underlying neoclassical economics (Himmelweit et al., 1998, *Firms*, pp.18-23). Simon proposes that economic agents use heuristics (learned rules, or commonly 'rules of thumb') to make decisions, rather than a perfectly optimising rationality. They do so because of the great difficulty in calculating their expected pay-offs from every available course of action (Simon, 1959). For these contributions, Simon won a Nobel Memorial prize in 1978, in receipt of which he prepared a speech that is also considered in this review (Simon, 1979).

Among the interesting implications of bounded rationality are that agents may have multi-valued utility functions, where outcomes are either satisfactory or unsatisfactory. This contrasts with the neoclassical model agent, who is never truly satisfied, always seeking a higher indifference curve by the neoclassical definition of maximising. Simon's bounded rationality is thus coupled with another of his original terms, that is satisficing, an amalgam of satisfy and suffice, the bounded rationality theorists' equivalent of maximising. Under satisficing conditions an agent ceases to explore new avenues for increasing the profit of a firm it controls, or even attempt increases in their own personal utility, once a satisfactory option is discovered (Simon, 1959). This can be a source of X-inefficiency (pronounced 'cross-inefficiency') in firms controlled by satisficing managers, to the dire consequence of shareholders, who suffer a principal-agent problem.

Sympathetic to bounded rationality theory, though not deeming it sufficient, Arthur states that agents' methods are not deductive, but *inductive.* (Arthur, 1994, original emphasis). Arthur's explanation is centred around the proposition that we are bad at, and do not constantly refer to deductive logic. We instead solve complex problems by using inductive powers of pattern-recognition to construct privately held, evolving *schemata,* as a simplification mechanism. Arthur likens the way we solve problems in this way, to the broadly evolutionary system of selection and rejection that drives scientific progress, and indeed evolution itself. To clarify, the following illuminating thought experiment is provided by Arthur, where multiple, heterogeneous agents construct subjective schemata, acting on the best-performing ones, and substituting them as necessary (providing a systematic hysteresis).

The bar problem:

> '*N* people decide independently each week whether to go to a bar that offers entertainment on a certain night. For concreteness, let us set *N* at 100. Space is limited, and the evening is enjoyable if things are not too crowded-specifically, if fewer than 60% of the possible 100 are present. There is no way to tell the numbers coming for sure in advance, therefore a person or agent: *goes*-deems it worth going -if he expects fewer than 60 to show up, or *stays home* if he expects more than 60 to go. (There is no need that utility differ much above and below 60.) Choices are unaffected by previous visits; there is no collusion or prior

communication among agents; and the only information available is the numbers who came in past weeks... Of interest is the dynamics of the numbers attending from week to week' (Arthur, 1994, pp. 5-10).

The author goes on to highlight two interesting features of this problem; if there were an obvious, neoclassical-style, highly predictable and simplified model for reference, agents in the bar problem would be able to 'forecast' attendance and base their decisions on a deductive logic. But retaining the assumption of heterogeneous preferences among agents, we realise the agents would either *all* stay home, or *all* attend the bar. Expectations would all be required to alternate in synchrony, or expectations will be 'forced to differ'. The solution to the dynamic model itself is as follows.

'Assume the 100 agents can individually each form several predictors or hypotheses, in the form of functions that map the past *d* weeks' attendance figures into next week's. For example, recent attendance might be:

...44 78 56 15 23 67 84 34 45 76 40 56 22 35

And particular hypotheses or predictors might be:

predict next week's number to be

- the same as last week's [35]
- a mirror image around 50 of last week's [65]
- 67 [67]
- a (rounded) average of the last four weeks [49]
- the trend in the last 8 weeks, bounded by 0, 100 [29]
- the same as 2 weeks ago (2-period cycle detector) [22]
- the same as 5 weeks ago (5-period cycle detector) [76]
- etc. ...

Assume each agent possesses and keeps track of a individualized set of *k* such focal predictors. He decides to go or stay according to the currently most accurate predictor in his set.... Once decisions are made, each agent learns the new attendance figure, and updates the accuracies of his monitored predictors.'

Here Arthur has modelled a situation where there is two-way causation in evolution, between chosen sets of predictors, and historic attendance. Taking things a step further by conducting an *inductive-reasoning system* computer simulation for the bar problem, some interesting results are achieved. In short, and perhaps because the available predictors were encoded rather conveniently, 'mean attendance converges always to 60 [%]' (Arthur, 1994, p. 9). Thus some very effective utility-maximisation seems to be achieved, despite any bounded rationality on the part of the agents.

Besides my initial doubts that the overwhelming majority of agents would prefer an empty bar, it seems fair to object that real (human) agents would not be able to codify their own chosen '*active*' predictors, in the forms Arthur has suggested they might employ, nor would agents attach exclusive importance to the result of such computations, considering other forces in their environment as well. The first, more technical objection to the predictors is in fact anticipated by the author, who suggests a more sophisticated computer procedure for testing is necessary, and that this would enhance the credibility of the model. Leaving scope for models of greater complexity and a better informed understanding of cognition, I believe the structure of the decision making in Arthur's bar problem model to provide quite an intuitive exemplification, as part of what is a very clear case against perfect, instrumental rationality. Combining the mechanics of selection and evolution with fuzzy decision rules seems very compelling.

Sources of Evidence

Experimental economics constitutes efforts to create economic simulations in controlled environments, providing data that may be more easily interpreted than the observed data used in most econometrics, where viable explanations can typically be more numerous. Such experiments have certainly provided some evidence in support of theories of boundedly rational agents, though I regret there are not a slew of studies reviewed here. But one excellent example of the neoclassical postulate of rationality being proven limiting under controlled conditions is to be found in the works of Allais (1953 cited in Novarese et al. 2004) and Kahneman and Tversky (1979, 1992 cited in Novarese et al. 2004). Though I do not know full details of how extensive the original experiments were, they have been 'often repeated by other researchers with more or less relevant variations' and shown 'systematic violations of the axioms of invariance, transitivity, and dominance, which lie at the basis of the theory of expected utility. In fact, the subjects use heuristic decision-making rules and make systematic errors in their choices' (Novarese et al. 2004, p.4).

Such experiments, that seem to bolster bounded rationality theory, certainly also have their critiques. Some of the first known experiments in economics, investigations into neoclassical indifference curves by Thurnstone (1931, cited in Novarese et al. 2004), were criticised by Friedman and Wallis (Novarese et al. 2004) for the problems they saw in translating the meaning of experimentally induced empirical results to the benefit of understanding real world behaviour. Major obstacles in doing so were suggested to include the hypothetical components to these experiments, or their artificiality (Novarese et al. 2004). I would agree much depends on sufficient care being taken in designing such experiments, for example substituting real remuneration for hypothetical remuneration. Computer simulations are clearly an interesting tool for scientists, though they bring their own acute dangers of artificiality, particularly in simulating complex, human interactions. 'Their legitimacy is only partly accepted' (Hodgson, 2007, p.10). Nevertheless, practical or theoretical difficulties in the computer lab should not void the methodological criticisms of neoclassical economics' core. I believe, in creating *realistic* multi-agent simulations, a perfect rationality would not be among the functions coded by the programmer. As long as parallels can be maintained in the light of ongoing developments in science, between computers and the human

brain, computers seem a very defensible place to conduct significant simulations of human agents.

Conclusions

This review set out to discuss some of the criticisms of the neoclassical conception of rationality, including an analysis of its importance in the model. Further to this, a special consideration has been made for whether bounded rationality can be accommodated as a replacement in a similar framework, and whether bounded rationality itself is even sufficient. It certainly seems that bounded rationality as a concept has eroded contemporary economics' reliance on perfect rationality and the neoclassical paradigm in general, leading to further attempts at the refinement and modelling of such ideas, as with the inductive reasoning of Arthur's bar problem (1994).

The article *Evolutionary and Institutional Economics as the New Mainstream?* by Hodgson (2007) reveals itself as a particularly rich and rounded source of interesting thought on the importance of rationality in modern economics. With excited tone, the author remarks 'Concerning the future of economics and its current potential for transformation, I am sufficiently uncertain to suggest that the question mark in my title should remain - at least for now' (Hodgson, 2007, p. 7). Hodgson's view seems to be that previously vanguard ideas, incompatible with the neoclassical research programme, have finally won over their critics and gained mainstream recognition. I can say from my own experience that while my most recent economics course at The Open University is not in its newest presentation, it has certainly been pluralist. This is in stark contrast to 1940-90, when 'the concept of endogenous preferences was criticised as theoretically unnecessary within economics and inconsistent with its basic theoretical approach' (Stigler and Becker, 1977, cited in Hodgson, 2007, p.11). This has lead to more widespread reconsideration of models allowing for socially endogenous preferences, and 'the belated mainstream recognition' (Hodgson, 2007, p.8) of Simonian bounded rationality. From a broadly methodological orientation, the various merits and problems pertaining to rationality in numerous sub-branches of modern economics are discussed in Hodgson's article (2007). It is asserted that game theory is more accommodating to institutional effects than standard neoclassical theory, and I agree, further stating that along side experimental economics, game theory has revealed the limitations of context-independent rationality, still, for the most part modelling agents with 'unrealistically powerful rational capacities'. In doing such, mainstream game theory is 'a monument to the limits of deductive general theorising in economics.' (Hodgson, 2007, p.9) By illustration of this, where game theory retains a 'common knowledge of perfect rationality' clause, there becomes scope for problems of, slightly hilarious, infinite regress. 'Long reasoning chains like 'if I think that she thinks that I think ...' emerge, often creating intractable logical problems' (Hargreaves and Varoufakis, 1995 cited in Hodgson, 2007, pp.15-16).

Arthur, (1994) proposes some interesting implications of his *inductive reasoning* for better understanding the economy, including stock market speculation, oligopoly pricing and product marketing, by accepting the existence of psychological patterns that may be non-recurrent and path dependent. I feel these points further suggest the author's dissatisfaction, as with many modern economists, with the fundamental assumptions of the neoclassical paradigm, that seem to have been the source of most wide-spread criticism of the economics discipline itself.

Perhaps most fundamentally, many of the arguments I have resurrected seem to be of a circular nature. The major feature of rationality in neoclassical economics, its self-interested aspect, as opposed to conceptions of a more communal motivation, seems to succumb to such a problem under analysis. It has to much excitement been proven in economics that trade can be to a mutual benefit. This does not defeat a Smithian assertion that it is carried out from a selfish motivation. Rothschild states that the *principal* rationality of the firm is obvious, as a profit-maximising entity, while at the same time conceding that this is not necessarily the only rationality of a firm. But in wondering what other rational objectives a firm truly seeks to attain, does it not seem these other objectives might be in conflict with profit-maximisation? Corporate social responsibility objectives, held by a firm whose activities are acutely unsustainable, seem like a natural contradiction, from a sardonic perspective at least. But in the long run such objectives could be entirely logically compatible with the truest, *long run* sense of profit-maximisation, especially were they formulated by sustainability-seeking firms themselves, rather than their often comparatively short-lived, satisficing managers.

Another similarly circular debate that I feel accompanies the literature is whether or not the central role of contextual scarcity, which is rarely defined (Hodgson, 2007, p.17), can include a description of agents' rational power. Given limited time and cognitive power, it does seem something approximate to perfect rationality to not spend many hours deliberating whether to consume honey, or marmalade for breakfast.

Last but not least, to the criticism of the surrealistically effective powers of instrumental rationality with which agents are modelled, the neoclassical marginalists' reply is that the power of a theory is not in its core assumptions, but in its predictive power. Indeed, criticisms of the neoclassical model's dubious assumption of perfect, selfish, instrumental rationality are perhaps the most facile criticisms of the orthodox mainstream economics. The majority of economists probably recognise that preferences are shaped at least partly by the world around us (Hodgson, 1997). The assumption of fixed, exogenous preferences is to be taken as a reasonable, deliberately simplifying assumption that is to the merit of the neoclassical model's usefulness. 'Models are not and cannot be adequate or literal representations of reality. Instead they are partial and provisional heuristics to help us understand and engage with real phenomena. Consequently, the current obsession by economists with formalism does not necessarily imply that closed systems are assumed in reality.' (Hodgson, 2007, p.18). The neoclassical model depends on the postulate of rationality, for its predictive power. Otherwise, 'economists would only be able to observe and describe outcomes alone' (Lange, cited in Rothschild, 1946). This seems like possibly spurious reasoning, for while I'd imagine there is little scope for the deduction of useful predictions from pure chaos by definition, as Arthur suggests 'Psychologists are in reasonable agreement that in situations that are complicated or ill-defined, humans use characteristic and *predictable* methods of reasoning' (Arthur, 1994, *my own emphasis*). I take from this that where there is predictability, it is reasonable to suggest modelling is possible, and so the neoclassical treatment of rationality cannot remain immune from criticism for its ease of modelling. Arthur does however also assert that no agreement has been reached as to what to substitute for perfect rationality. In sharp contrast to the neoclassical defence, a damning critique is delivered by Mark Blaug (1997, cited in Hodgson, 2007, p.18); 'Modern economics is sick. Economics has increasingly become an intellectual game played for its own sake and not for the is practical consequences for understanding the economic world. Economists have converted the subjected into a sort of social mathematics in which analytical rigour is everything and practical relevance is nothing.'

Fritz Machlup, in what is known as his 'theory of overtaking' (1946, cited in Himmelweit et al., 1998, *Firms*, pp.19-21) provided a very valuable analogy that I feel captures many of the dynamics of the old debate as to whether the strong assumption of perfectly rational decision-making in the neoclassical model defeats its purpose. In drawing up a long list of the considerations that ought technically be required to enable one road user to overtake another, Machlup

urges that the process of muddling-through that enables agents to behave, more or less, *as if* they maximised, need not be explained to be accomplished; a critical mass of agents do behave *as if* maximising with some intimidating powers of rationality, and this is why the agents can be justifiably modelled so.

I set out here some key proposals formulated in the literature referenced, for the future of related research in economics. Hodgson (2007) urges economists to engage more with the idea of 'social preferences', including those genuinely selfless ones (I hesitate to use the word 'altruistic', because the neoclassical framework has proven ready to accommodate those preferences, when they are stable). Hodgson also prescribes a stronger grounding in the historical development of economics, including philosophy of science, in the teaching of economics (Hodgson, 2007, p.19) and emphasises the need for greater interdisciplinary dialogue, including with psychology, for the furtherance of economics. This in particular seems very agreeable. Indeed, *'Bounded Rationality of Economic Man: Decision Making under Ecological, Social, and Institutional Constraints'* by Landa and Wang (2001) is an inter-disciplinary work, as was Simon's very central input to the discussion reviewed here.

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